The remote control transmitter system »Kehl«

The remote control transmitter and its accessories

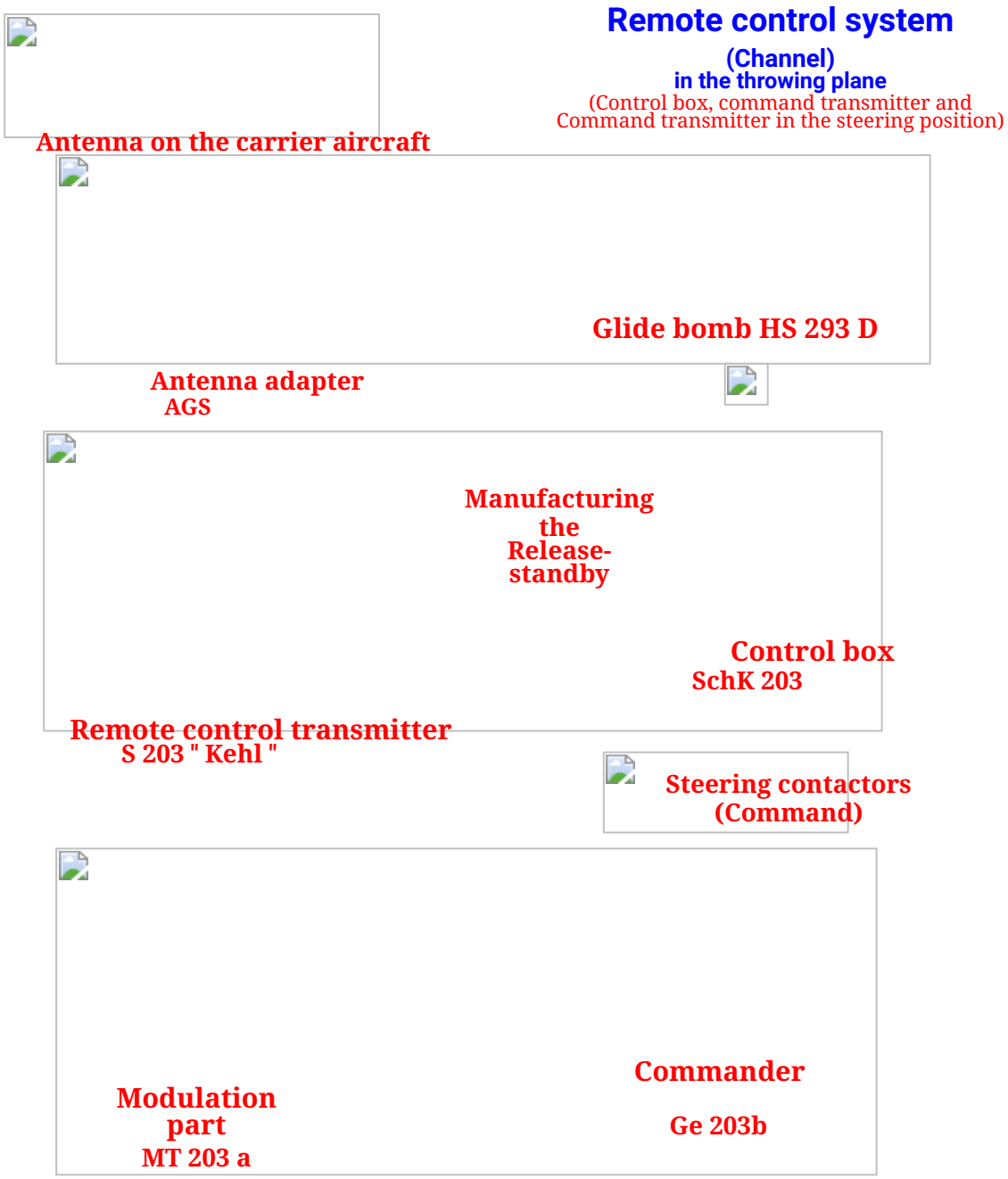


Image 140
Components of the radio remote control system (transmitter)
Command flow from the transmitter to the transmitting antenna - making ready for release (SchK 203)

The functional diagram in Figure 140 is intended to provide an initial orientation for the control and operating devices of the remote control transmitter that are present in the bomb-throwing aircraft. Blue arrows mark the direction of the command flow.

Let's start by looking at image 140 on the right:

The *SchK 203 switch* box was responsible for setting the system functions required for bombing. It was from him that readiness for release was established. In addition, the internal temperature of the Hs 293 could be transmitted to the aircraft during the transport phase via a line returning to the aircraft (symbolized by the purple arrow).

For direction control of the air-to-ground steering body, the drop bomb PC 1400X (*»Fritz X«*) and the various variants of the mine glide bomb Hs 293, which was equipped with a television device in a later special version (Hs 293D), a radio remote control had to be provided to operate the rudder devices of the missile. A good

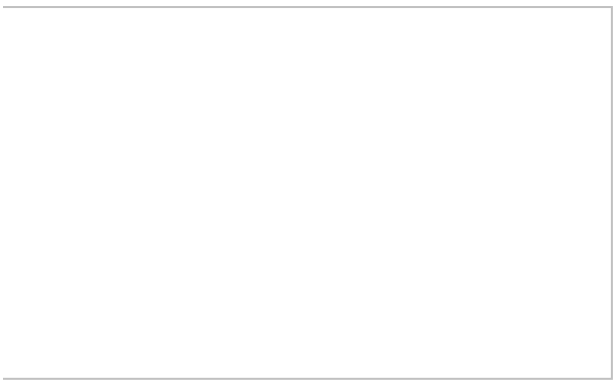


Fig. 141

Radio remote control transmitter system *FuG 203 b*
***"Kehl III"* in the steering position of a HE 111**
(from *Trenkle*, edited)

printing of essential, but by no means all, system components is shown in Fig. 141.
th part of the latter are shown modulation device and transmitter not in the vicinity of the Steering gates, but depending on Aircraft type, deposited at different places in the *He 177* z. B. in the rear part of the cell le, were mounted.

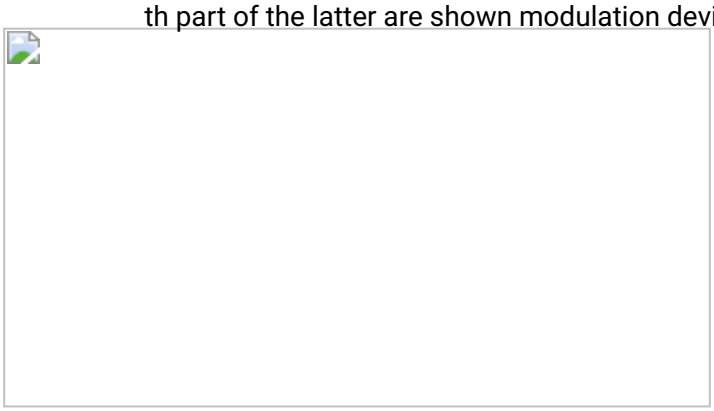


Fig. 141 b
Polar coordinate encoder to control the Hs 293
in the cockpit of a He 111
(Photo: Air Force Test Site - Peenemünde-West)

The steering sensor Ge 203b
(*»Kehl III«*)

Figure 141 shows the joystick-like control stick on the command *transmitter Ge 203b* , which is operated by the steering *wheel* . To the right of this is an early version of the

SchK *203 box* , which was later expanded to include a number of operating elements (sw u.).

The modified Geber *203b* (*"Kehl III"*) had the same dimensions as the *Ge 203a* (*"Kehl I"*), as described in detail above for the *"Fritz X"* . He was responsible for controlling the *»Fritz X«* according to Cartesian coordinates as well as for the Hs 293 suitable according to polar coordinates (*Stüwe*).

The development of the *Ge 203b* was in 1939 with the DVL (*German Research Institute for Aviation ride*) and the *Henschel aircraft factory* instead, was in 1940 in *Opta radio stations* in

Leipzig continued and has also been built there.

As with the *Ge 203a* , it also generates control signals of different durations from the continuous tone signals made available by the modulation *device* . The transmitter signal is modulated in amplitude by means of these sound frequencies, which are timed by the transmitter rollers - here called switching rollers or cam rollers .

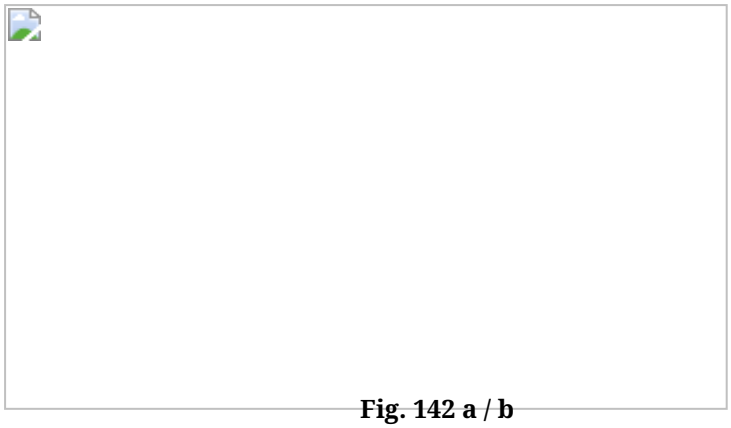


Fig. 142 a / b
Commander Ge 203b (*"Kehl III"*)
Left: Encoder with connection socket (*List*)
(from *storm*)
Right: encoder in command position
(Photo *Schröer* , object *Beck* Collection)

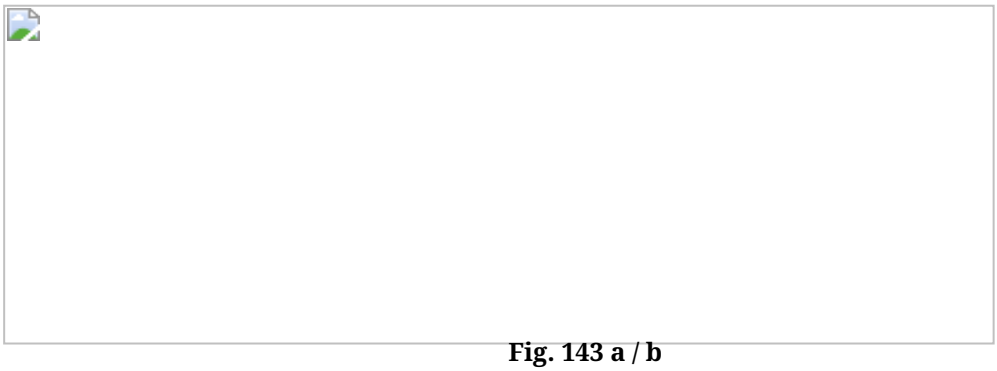


Fig. 143 a / b
Polar coordinate command generator Ge 203b (to control the HS 293)
Left: Encoder with polar coordinate scales
Right: encoder, underside cover removed (interior view)
(Photo *Geßwagner* , edited)

The differences to the *Ge 203a* encoder are *interesting* . It had no scales on which any settings of the steering stick could be read, which would not have made sense with a drop bomb anyway. *This* is different with the *Ge 203b* . The control stick sits here on a spherical transducer cap, over the surface of which a scale for pushing and pulling is 'stretched ', from the center point (0) on two sides at 10 ° intervals up to 50/0/30 is divided.

The scale, which completely encloses the encoder dome on its outside, is divided at the top with 0 ° and from there to the left and right in each case 180 °. It is apparently responsible for leaning to the left or right. At high speed, the Hs 293 could be placed in very 'steep ' curves.

The ability to control almost any point between the two scales through the position of the control stick is equivalent to setting point P on the spherical surface according to polar coordinates (see Fig. 145).

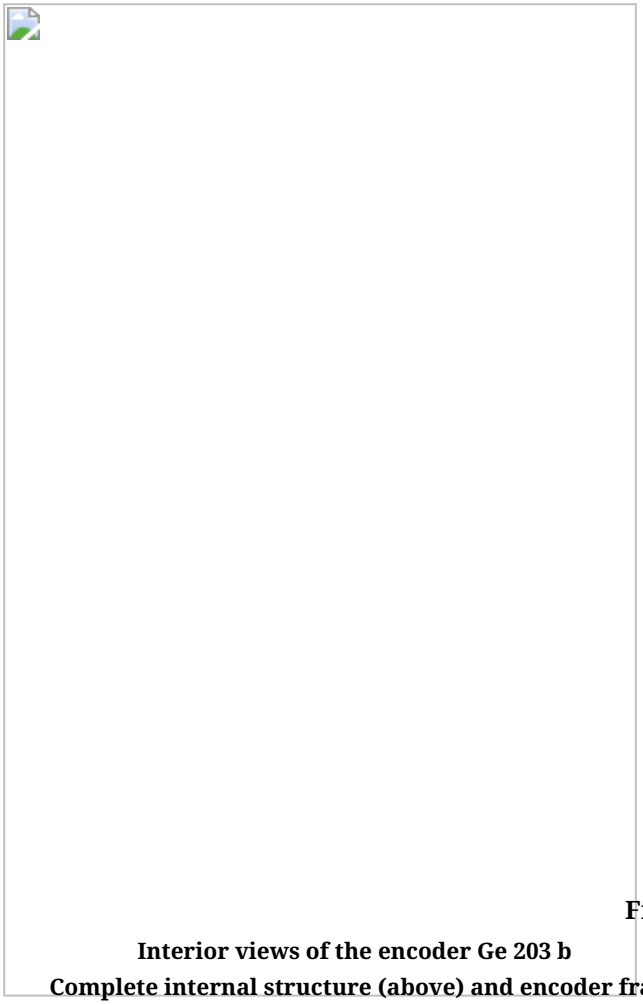


Fig. 143 c / d

Interior views of the encoder Ge 203 b

Complete internal structure (above) and encoder fragment without motor and cam rollers

Synchronous motor (600 rpm) lever of the sliding contacts

Guides (drivers) for the sliding contacts

Cam roller contact feeds for the sliding contacts

Red arrow: guide rod for sliding contact lever

Yellow arrow: spiral cam on the cam roller

(Photo above: *Geßwagner* - Photo below: *Sigmund* , both edited)

A special marking between - 10 ° and - 60 ° (Fig. 144) is noticeable on the scale arch that surrounds the dome . The following consideration seems suitable as an explanation for this :

In the carrier aircraft, the pilot was always on the right side of the cockpit next to the pilot. As a result, he had poor visibility to the left, so it made no sense to put the Hs 293 into a left turn shortly after take-off. Only in the later course of the steering process was this target area free for the shooter, and cornering commands also made sense in this direction. Speculation!

The ' inner life ' of the *Ge 203b* is particularly interesting , details can be seen in Fig. 143. It is clear from them that a construction that is completely different from the *Ge 203a has* been chosen.

Unfortunately, only a few elements can be identified reliably to some degree from the images [1] . In Fig. 143c, this includes the speed-controlled drive motor for the cam rollers, which, according to *Stüwe, drives them* at 600 rpm. turned. This corresponds to a rotational frequency of 10 Hz = 10 rev / s), which was passed on to the rollers without reduction [2] .

[1] Function descriptions, construction sketches and circuit documents were not available.

[2] With the Ge 203a, a 2: 1 gear reduction provided 300 rpm. on the rollers, corresponding to 5 Hz.

Two sliding contact levers running in a swivel joint are located on guide rods (red arrow in Fig. 143c). They rest on the two contact rollers that can be seen in the lower part of the picture. Part of the spiral switching cam can be recognized by the yellow arrow.

The commands are transferred from the joystick on the left in an inclined groove (carrier) to the cam roller, the right roller seems to be guided over the cam roller via a screw drive.

Audio-frequency signal feed and decoupling of the sampled signals is apparently carried out via two separate contacts on each contact lever.

Fig. 144
Commander Ge 203b
with nameplate
and
blocked command area
15... 60 ° left (arrow)

(Photo by *Sigmund* , edited)

This functional description is based to a large extent on assumptions, since the steering stick transmission to the roller system could not yet be determined; a functioning encoder is currently not available for investigations.

Finally, it should be noted that you can later

- apparently in an effort to reduce the geometrical dimensions of the device - has developed a command transmitter which no longer scans the audio signals supplied by the modulation device on contact rollers . The *roller taps used* in the *Ge 203a* and *Ge 203b* are replaced by a toggle switch (multivibrator) with polarized telegraph relays and two ' linear ' potentiometers moved by the control stick . This construction made it possible to simplify the mechanics considerably while maintaining the same function and thus to produce it more cost-effectively, another example of effective 'refinement '.

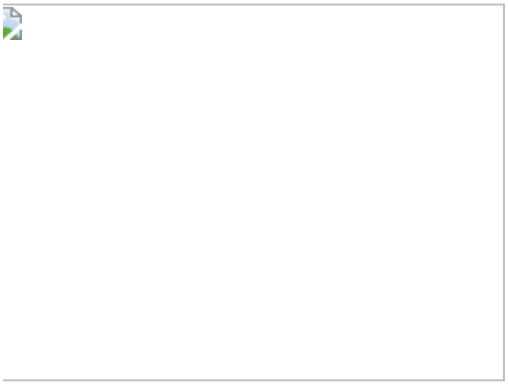


Image 145

Polar coordinates

Spherical coordinates are plane *polar coordinates* ,
which are supplemented by a third coordinate. Suitable for sensitive control with graduated control signals
(based on *Wikipedia* , edited)

Special features of the steering device for the Hs 293
Control according to polar coordinates

Unfortunately there are z. Z. neither circuits of the various command transmitter designs nor the modulation part are available, so that their function is not up to

Detail can be tapped. After all, basic circuit diagrams allow essential components to be identified.

The specialty of the Hs 293 glide bomb is the control according to polar coordinates. This is an advantage in an aircraft-like missile that is supposed to fly real curves with the help of ailerons, because it reacts more sensitively than the control according to Cartesian coordinates.

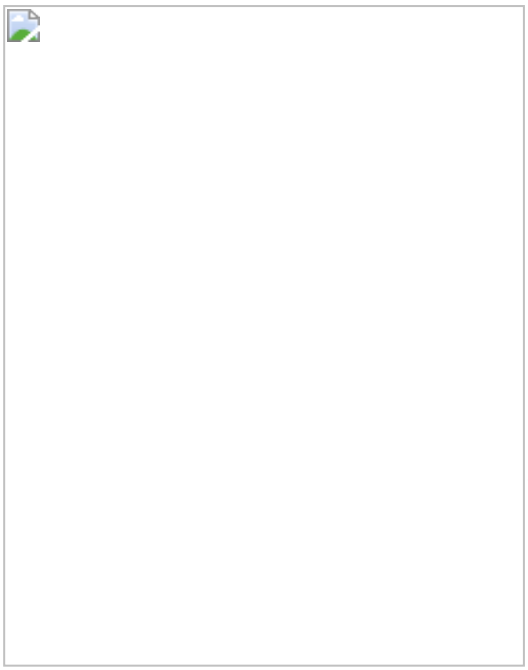


Image 146

Shift drums of the commander Ge 203b
(*»Kehl III«*)

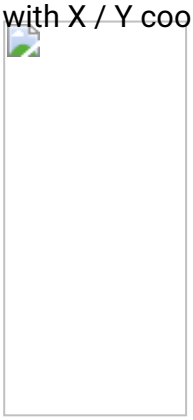
Above: Camshafts I and II
Z = pull D = push
f1 / f2 = tone frequencies 1.0 and 1.5 kHz
AB = current position of the sliding contact on the contact roller I.
LN = inclination to the left RN = inclination to the right
F3 / f4 = audio frequencies 8 and 12 kHz C-D = current position of the sliding contact on the contact roller II

Center:
Cross-section through the contact rollers I and II at the level of the position of the sliding contacts KK1 and KK2

Below:
Result of the encoder creation:
Drag - Left

Are we looking at the difference between the two?

The polar coordinate system is a two-dimensional system in which every point in the plane is defined by an angle (!) And a distance. These coordinates are used when the relationship between two points can be described more easily by these values than can be achieved with X / Y coordinates in the Cartesian coordinate system.



In the polar coordinate system, each point is defined by the radial and angular coordinates. The radial coordinate (r) denotes the distance that this point has from a central point, the so-called pole. In the Cartesian system it corresponds to the "origin ". The angle coordinate, also called polar angle or azimuth angle, and with the symbol

(or denoted t) corresponds to the mathematically positive, i.e. counterclockwise rotated angle that the point assumes starting from the 0 ° straight line (= polar axis) (equivalent to the positive X-axis in the Cartesian coordinate plane) (see Fig. 145) .

In radio navigation, the polar coordinate system is also known as *"Rho- Theta"* for direction and distance measurement.

Image 147
Cam roller
of
Polar coordinate
Encoder *Ge 203b*

(Model)

Figure 148 shows the effects of selected commands on the position of the remote-controlled missile. Pulling or pushing is symbolized by up and down arrows. Right and left inclination of the transverse axis of the Hs 293 lead to a flatter flight path and turn at the same time.

A similar representation is selected in Fig. 149. Here a specific position of the *Ge 203b encoder* shows the effect on the missile with maximum lift (pulling) and a 30 ° incline with the wing 'hanging ' on the right .

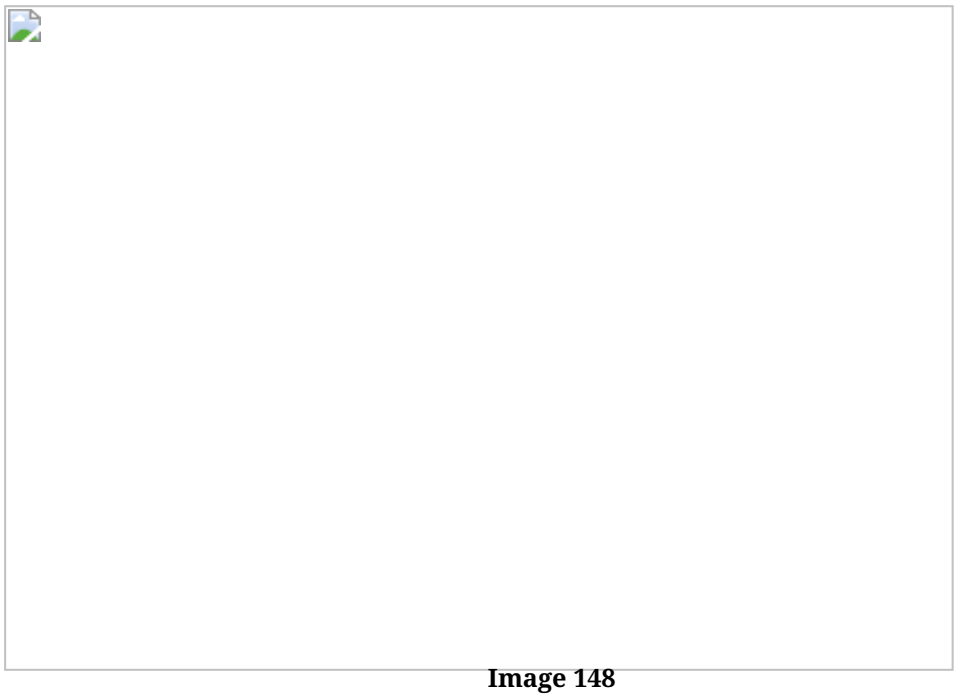


Image 148
Issue of command and effect on the position of the Hs 293 in space
(from *Thiele* ; original from *the Luftwaffe test center, Peenemünde-West,* edited)

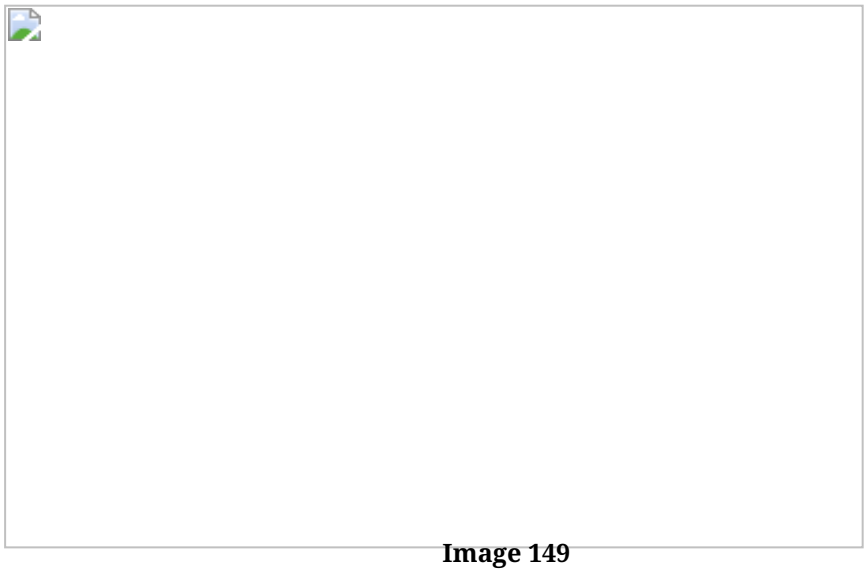


Image 149
Encoder position and position of the Hs 293 in space
(from *Wagner* , edited)

The modulation part MT 203

An external view of the MT 203 modulation part is shown in Fig. 150. The assembly is housed in an aluminum housing that is closed on all sides and only contains the openings for the four trimmers *O 1* to *O 4* (oscillator 1 - 4) for fine-tuning the tone generators, and also each a socket for connecting a test voltmeter and for the blade contact strip, via which both the *Ge 203* transmitter is supplied with the audio signals and the operating voltages are fed to the device.
There is also a line on the blade contact strip that runs from the encoder output to the LF transformer (transformer); this is also in the modulation section (Fig. 152).

Fig. 151 shows the components on the top of the solid cast aluminum chassis. On the left you can see the four oscillating circuits of the audio frequency oscillators (so-called buzzer, designated as *S1* to *S4*), on the right next to them the four tubes of the audio frequency oscillators (RV 12 P 2000). The circular clay coils are wound on pot cores, the parallel capacitors are directly below them (Fig. 151/152).

Fig. 150 a / b
Left: MT 203 modulation section
Yellow arrows:
Adjustment openings
for tone oscillators
Red Arrow:
Socket for connection
a test voltmeter PV 203
(Photo: * changed)

The two tubes on the top right belong to the low-frequency amplifier for the audio signals going to contacts *KK1* and *KK2* (Fig. 151). The red arrow in Figure 150 points to the connection socket for a test voltmeter (see Figure 150b), as was typical for the individual components of the entire radio control system [3].

Fig. 152 shows the underside of the device. On the left of the thick-walled injection-molded support plate are the height-proof, hermetically soldered capacitors *C1* to *C4* for the sound generators. The green arrow points to the modulation transformer, from which the audio frequencies clocked by the *Ge 203* transmitter are forwarded to the transmitter output stage. In doing so , it transforms the audio signals to the level required for modulation with simultaneous galvanic isolation.

Back to the encoder:

As shown above, the Hs 293 resembled an airplane with its slightly trapezoidal stubby wings, the flight behavior of which was dictated by its design. Steering methods that worked with polar coordinates had to be trained by the guardsman - due to the elimination of motor-controlled rudders.

As described above, the sensor *Ge 203* ***b*** (Fig. 142) designed for this purpose also generated control signals (tilt to the left / tilt to the right - pulling / pushing) that were adapted to this situation

[3] A special test voltmeter was available for each device, the instrument of which was not calibrated on the scale. The various test tasks were selected by switches, series resistors defined the areas. Only target value segments were colored on the scale (markers) so that even untrained personnel could make settings and function checks.

With the help of mechanically rotating rollers, which are driven by a speed-controlled DC motor with 600 revolutions / minute (encoder *»Fritz X«* 600 rpm, but with a 2: 1 reduction, i.e. 300 rpm on the rollers) were [4].

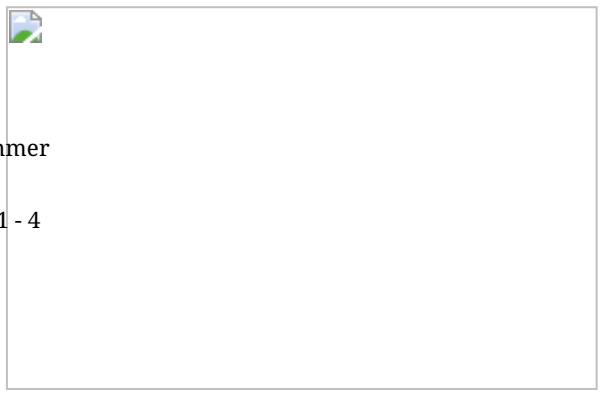


Image 151
Modulation part MT 203
Yellow arrows:
Tone Oscillator Adjustment Trimmer
for O 1 to O 4
Blue double arrows:
Oscillator coils for tone circles 1 - 4
Red Arrow:
Socket for connection
of the test voltmeter
Green arrow: see text
(Photo: * changed)

The assignment between stick position and command values was achieved through a suitable shape of the contact paths. The temporal relationship between the two tone frequencies used to

control a rudder - generated in the separate MT 203 modulation device by self-oscillating tone generators - creates a clear relationship between stick position and pulse duty factor of two tone frequencies.

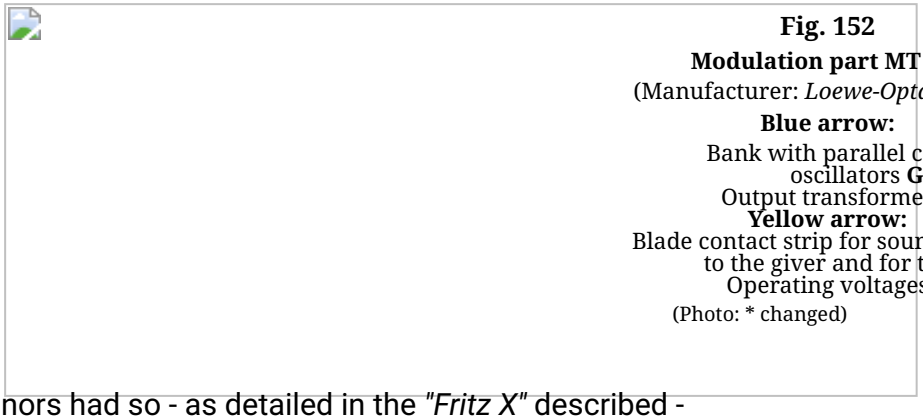


Fig. 152
Modulation part MT 203
(Manufacturer: *Loewe-Opta* -Werke)
Blue arrow:
Bank with parallel capacitors of the tone oscillators **Green arrow:**
Output transformer
Yellow arrow:
Blade contact strip for sound signals to the giver and for the Operating voltages
(Photo: * changed)

The donors had so - as detailed in the *"Fritz X"* described -

"The task of placing two command contacts periodically at the frequencies F1 / f2 and F3 / f4 in such a way that command values corresponding to a certain position of the ' control stick ' operated by the steering gate , ie a different duration of the frequencies f1 / f2 for one axis and F3 / f4 were created for the other axis " (*Trenkle* [2]).

In this basic mode of operation, the encoder for the *»Fritz X«* , provided for control according to Cartesian coordinates, does not *differ* from the *Ge 203b* for the Hs 293, which was designed for polar coordinate control. The relationships shown in Fig. 153 also apply here.

4 Later the mechanical command transmitter was replaced by a multivibrator, among other things to eliminate the phase jump error, which arises from the fact that when switching one of the independently oscillating LF generators to another, a voltage jump can occur which is caused by the relative phase position the LF voltages at the moment of switching depends. This leads to a 'restlessness ' on the rudders of the steering body (for details see *Stüwe*).

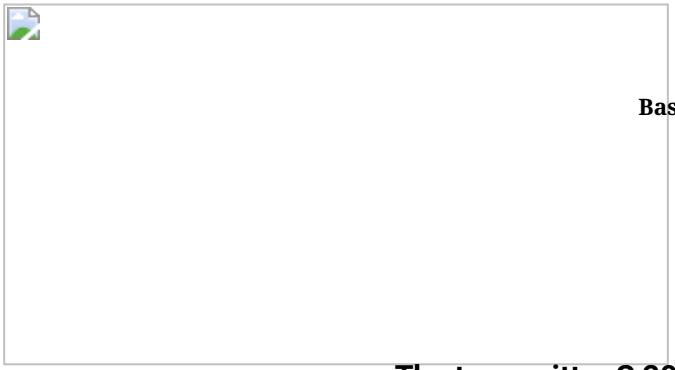


Image 153
Basic circuit diagram of the radio remote control
Transmitter system *FuG 203 »Kehl«*
F1 - F4 **-** tone frequency generators
F1 *= 1 kHz* ***F2*** *= 1.5 kHz*
F3 *= 8 kHz* ***F4*** *= 12 kHz*
KK1 and ***KK2*** **-** command ***contacts M*** **-** motor in the command ***transmitter*** (see text)
(from *Trenkle*, edited)

The transmitter S 203 *»Kehl«*

As mentioned above and shown in the basic circuit diagram in Figure 153, the control signals reach the *S 203* transmitter via an LF transformer built into the modulation section , which is then modulated in the screen grid of the two power stage tubes connected in parallel [5] .

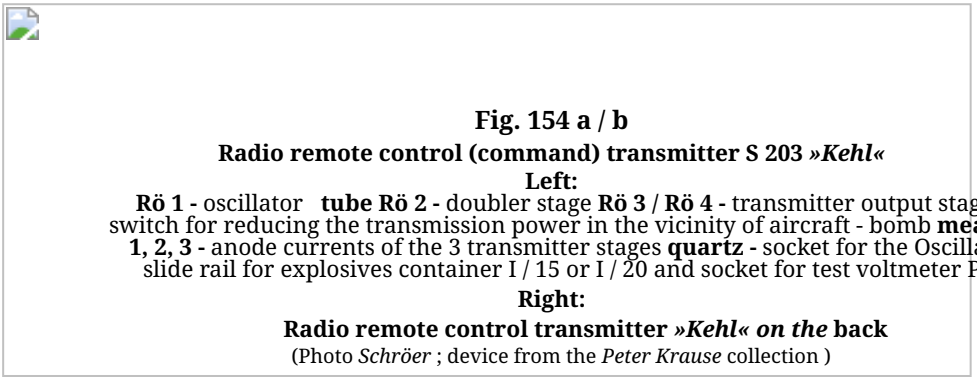


Fig. 154 a / b

Radio remote control (command) transmitter S 203 *»Kehl«*

Left:

Rö 1 - oscillator **tube Rö 2 -** doubler stage **Rö 3 / Rö 4 -** transmitter output stage **switches 1, 2, 3 -** switch for reducing the transmission power in the vicinity of aircraft - bomb **measuring instruments 1, 2, 3 -** anode currents of the 3 transmitter stages **quartz -** socket for the Oscillator quartz crystal - slide rail for explosives container I / 15 or I / 20 and socket for test voltmeter PV 203 on the right

Right:

Radio remote control transmitter *»Kehl« on the* back

(Photo *Schröer* ; device from the *Peter Krause* collection)

The 3-stage 50 watt transmitter (*Telefunken*), with exchangeable quartz oscillator and an LS 50 in the control stage (oscillator), is tuned to the quartz frequency in the anode circuit of this tube. This is followed by a doubler stage with another LS 50, which

5

The simultaneous transmission of four audio frequencies as modulation on an RF carrier does not lead to any significant intermodulation problems if the amplification is quasi-linear on the transmitter and receiver side. On the receiver side, the four 'spectrally ' largely pure audio frequencies can then be separated separately from the carrier wave by filters. In the case of stronger non-linearities, intermodulation mixtures would form between the audio frequencies, making a clear separation according to frequency and amplitude more difficult, and in extreme cases impossible.